of the exposure, but if photographs obtained with longer exposures are utilised for the determination of the relative position of stars, it will be necessary to know what star on the plate was used as guider, and the distortion by refraction must be investigated for all stars at any considerable distance from it." From this it will be seen that the photographs of stars obtained for the determination of parallax, or in connection with the star catalogue, are unaffected by the result, since the exposure in each case is usually less than the limit defined by Prof. Rambaut.

ASTRONOMY POPULARISED.—We have previously referred to a proposal to issue a new astronomical periodical, designed for amateurs, teachers, students of astronomy, and the public generally. The first number of this *Popular Astronomy* will be published about September 1, by Mr. W. W. Payne, Goodsell Observatory, Carleton College, Northfield, Minn., U.S. Messrs. William Wesley and Son, 28 Essex Street, Strand, London, are the agents for England. The periodical will be issued monthly, but no numbers will be published for July and August of each year. One of the features will be a scheme of work suitable for a small telescope, field glass, opera glass, and the naked eye. Those who wish to know their way about the sky will find their wants supplied, and home readers will be catered for by means of lists of best books and schemes of study. From these and other matters mentioned in the prospectus it seems probable that the periodical will possess the features that command success.

COMET APPEARANCES IN THE YEAR 1892.—Prof. H. Kreutz has collected together all the appearances of comets during the past year, this list appearing in the *Vierteljahrschrift der Astronomischen Gesellschaft*, 28 jahrgang, parts 1 and 2. In addition to short descriptions of the appearances put on by them at the times of discovery, and to the values of the elements of the new ones, he gives references to all the observations that have been made of them. Among those that receive more than usual attention are Comet 1892 I., discovered by Swift; Comet Holmes (1892 III.), Winneike's Comet (1892 IV.), and Comet 1892 V. (Barnard), since it was the first (excluding that photographed in the Solar Eclipse of May 17, 1882) discovered by photography.

GEOGRAPHICAL NOTES.

THE Society for the study of French Congo has organised a strongly-manned expedition to survey the valley of the Kuilu and Niadi rivers, in order to ascertain the feasibility of constructing a railway from the coast town of Loango to Brazzaville on Stanley Pool. A geological and botanical staff accompany the survey party, and the whole is under the command of M. A. Le Châtelier, who, with fifteen French members of the expedition, sailed from Marseilles last week.

RUSSIAN authorities are determined this year to test the capabilities of the Kara Sea route to Northern Siberia. A small fleet of three vessels, specially built on the Clyde for navigation on the Upper Yenesei, has recently set out in charge of Russian naval officers, who are confident of making a rapid journey. Capt. Wiggins is also in charge of some vessels laden with railway material for the great trans-Siberian line, which are now on their way to the Kara Sea. Dr. Nansen, in the *Fram*, must now be very near the entrance to the Kara Sea, and the nature of the ice there will determine which of the three routes into the sea will be attempted. The ultimate establishment of a commercial steamer service is only a matter of money.

IN a racy little pamphlet, *La Géographies dans les Chaires de l'Université*, Dr. Maurice Viguier makes a raid on a number of elementary text-books published by the leading geographical professors of Paris, and he succeeds in showing many errors of statement which should be set right. He goes on to argue that the inaccuracy of these popular schoolbooks, written to satisfy an arbitrary syllabus, proves the geographical incompetence of the authors. Few eminent men in any country could stand such a test, and in truth the faults cited and held up to ridicule so cleverly are faults of composition rather than of fact, and the worst are due to the ambiguity of words in common speech.

PRELIMINARY arrangements are being made for the meeting of the Sixth International Geographical Congress in London in 1895. This congress will be under the patronage of the Queen, and will bring together the geographers from all countries for the discussion of questions in which the international or universal side of geography will be kept to the front. The month of the proposed meeting has not yet been fixed.

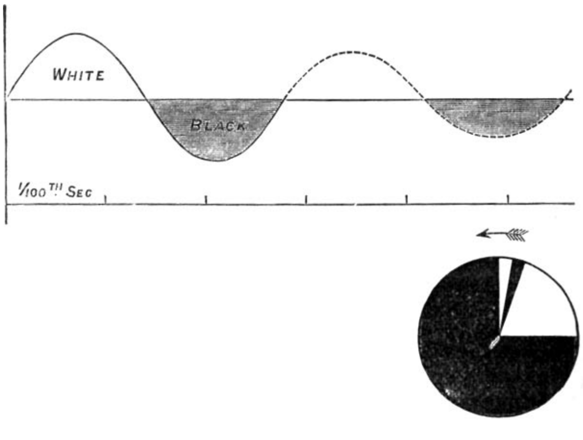
THE Central African telegraph line, projected by Mr. Cecil Rhodes, has been already commenced, and contracts have been signed for its construction from Fort Salisbury as far as Lake Nyasa. The wire will be carried on iron poles, and taken across the Zambesi (a distance of about half a mile) overhead at a height sufficient to allow the traffic on the river to pass entirely unimpeded. The advantage of this line in bringing the region of the great lakes into telegraphic touch with Europe will be very great.

CHARPENTIER'S EXPERIMENTS DEMONSTRATIVE OF AN OSCILLATORY PROCESS IN THE ORGAN OF VISION AND OF ITS DIMENSIONS.

ONE of the fundamental positions in Hering's physiological theory of visual sensation is that each sensificatory datum diffuses in the retino-cerebral organ beyond its precise locus of incidence, and thus directly modifies contiguous sensificatory data. A very elegant experimental substantiation of this position is contained in two simple optical observations by Charpentier[1] (of Nancy) giving not only the clearest possible demonstration of the fact itself, but an approximate measure of the physiological duration and velocity of the phenomenon.

These experiments are (1) that of the "black sector," demonstrative of a retino-cerebral oscillation; (2) that of the "fluted band," demonstrative of the propagation of that oscillation.

(1) *Charpentier's experiment of the Black Sector.*—A black disc with a white quadrant, revolving once in two seconds, illuminated by a very bright light (preferably direct sunlight). Observer's eye fixed upon centre of disc. A narrow black sector appears on the white quadrant near the receding edge of the black surface. This is interpretable as a rebound effect indicative of an oscillatory process in the retino-cerebral organ; the first effect at the arrival of the white border is the sensation of white, and this first effect is followed by an after-effect that is black. On closer examination it may be noticed that the angular breadth of the black sector is equal to the breadth of the white interval between it and the receding black border, and that these breadths increase and diminish with increase and diminution in the speed of revolution; estimating from this speed and from the apparent extent and position of the black band, Charpentier finds that the white phase and the black phase have each a duration of ·014 to ·016 second, *i.e.* that a total oscillation of the two phases lasts ·028 to ·032 second, *i.e.* that the oscillation frequency is 36 to 31 per second.



Nothing can be clearer and more striking than this experiment; provided a strong light is used, it can be roughly demonstrated without any elaborate apparatus; it can be done by a black and white disc slowly turned round by hand, or by a

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[1] *Comptes Rendus*, Soc. Biol., Mai 16, 23, 30, 1891. *Comptes Rendus*, Acad. Sc., Juillet 27, 1891. *Arch. de Physiol.*, Juillet et Octobre, 1892.

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black and white card moved horizontally in front of the eyes. The estimates that I have made with proper apparatus very closely correspond with the value as originally determined by Charpentier. With a disc revolving once in two seconds, I find the apparent angular magnitudes of the two phases equal to about 2°·5; with a disc revolving twice as fast they are about 5°.

(2) *Charpentier's experiment of the Fluted Band* is somewhat more difficult of performance and of interpretation. A black disc, 45 cm. in diameter, revolving about twice per second, with a small white spot (1 cm. × ·5), 20 cm. from the centre. Observer's eye fixed upon a bead placed in front of the disc at that distance from the centre. Under these circumstances the white spot appears stretched out to a white band with indefinite beginning and end, which appears to be composed of several alternately lighter and darker portions of longer light internodes with shorter dark nodes. Whereas in the experiment of the black sector, the apparent angular magnitude *increases* with increased speed of revolution, in this experiment the angular magnitudes of the nodes and internodes *diminishes* with increased speed (or what amounts to the same thing, with approximation of the observer's eye to the disc) and *vice-versâ*.

Charpentier explains this at first sight very puzzling relation by the following hypothesis, which is at the same time an ingenious application of a well-known physical principle to a hypothetical physiological wave transmission *and a proof of the existence of the latter.* Upon the incidence of the stimulus white, an oscillation of sensation is produced, of which the first or positive phase is white, the second or negative phase black; each phase has a duration of about 0·015 sec.—*i.e.* the entire oscillation has a duration $t = 0{\cdot}03$ sec. and a frequency n of 33 per sec. This much is demonstrated by the experiment of the black sector. Let us now suppose that the oscillation spreads from its origin in the organ of vision[1] over the remainder of that organ, as an oscillation at one point of a pond spreads over the remainder of the pond. The problem is to determine the velocity of transmission v and the wave-length l of this presumably *propagated* oscillation. This is done by Charpentier by the following physiological application of Döppler's principle *re* the apparent modification of sound-waves according as the distance between origin and ear is increasing or diminishing.

In accordance with a familiar relation, wave-length l is equal to velocity v, multiplied by duration t, or $l = vt$. In accordance with Döppler's principle the apparent rise of tone or the apparent diminution of wave-length caused by the approximation of observer and wave origin, are such that $l' = (v - v')t$, where l' is the apparent wave-length, and v' the velocity of approximation.

If we were debarred from measuring tones proceeding from stationary origins, we might nevertheless determine their wave-length and velocity by calculation from measurements of the apparent wave-lengths of tones proceeding from origins moving at different known velocities. From two equations, $l' = (v - v')t$, $l'' = (v - v'')t$, we should have $t = \dfrac{l' - l''}{v'' - v'}$ and its reciprocal, $n = \dfrac{v'' - v'}{l' - l''}$ and (substituting $\dfrac{l}{v}$ for t) $v = \dfrac{l'v'' - l''v'}{l' - l''}$ and $l = \dfrac{l'v'' - l''v'}{v'' - v'}$.

These are, in fact, the data experimentally accessible in the retinal phenomenon. We cannot (as far as is known at present) measure the velocity and length of a retinal wave with stationary origin; we must determine these values from their apparent values with the wave-origin moving at different known velocities.

Practically the velocities v', v'', &c., of the wave origin on the retina are easily adjusted; the apparent wave-lengths l', l'', &c., more or less accurately observed. Given the dimensions of the disc, its distance from the eye and its rate of revolution, the experimental velocities are easily calculated; similarly if the apparent dimensions on the disc of the nodes and internodes are accurately observed, the retinal wave-lengths corresponding with them can be accurately calculated. It is in this second determination that the chief experimental error can arise; nevertheless, considering the original conditions of the problem and that this is, in fact, the first time it has been approached and solved by any method, the results given by Charpentier are, within limits, sufficiently demonstrative of the propagation of a retinal oscillation and of its approximate velocity and wave-length. He finds from a large number of measurements a *velocity* between the limits of 53·8 and 90 mm. per sec. (mean value, 72); a frequency between 28 and 54 (mean value, 36); a calculated wave-length on the retina of 2 mm.; and a calculated wave-duration of 0·028 sec.

Not the least satisfactory feature of these figures is that the value of the wave duration derived by the indirect method of this more difficult experiment, practically coincides with that derived from the simple and easy experiment of the black sector.

A third experiment of Charpentier's, although not precisely confirmatory of these, seems to stand in some relation to the negative semi-vibration manifested as the black sector. A black disc with open sectors, revolving between the eye and a white sheet illuminated by direct sunlight, gives rise to the sensation of a magnificent purple colour, when the rate of revolution is such that the eye receives between 40 and 60 stimuli per second, *i.e.* when each stimulus occurs during the negative phase of the preceding stimulus. Above 70 and below 30 stimuli per second the sheet appears white. The effect is very striking and very easily obtained; in short, it is a "ladies' experiment"; its full explanation is a different matter, and far too uncertain for discussion in a short article.

A. D. W.

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[1] It is essentially indifferent whether we take organ of vision to signify the retina or brain or retino-cerebral apparatus. It is convenient to refer measurements to the retina itself, and to determine retinal velocity and retinal wave-length.

THE POSITION OF SCIENTIFIC EXPERTS.

FROM time to time it has been pointed out in these columns that the services rendered to litigators as such by so-called scientific experts is antagonistic to the pure spirit that should actuate men of science. For some years the position and character of the representative of science in courts of justice has been acquiring interest, not only in England but elsewhere. In fact, a few years ago a Committee of the American Association for the Advancement of Science was appointed to consider the whole matter, but no report of their proceedings has yet been published. An excellent discussion of the subject, however, comes from America in the form of a reprinted lecture on "The Scientific Expert in Foreign Procedure," by Prof. C. F. Himes, which appears in the June number of the *Journal of the Franklin Institute.* In order to direct the discussion, Prof. Himes first gives legal opinions as to the status of the expert. "Justice Miller," he says, "exhibited a plan of objection in a charge as follows:—'My own experience, both in local courts and in the Supreme Court of the United States is, that when the matter in contest involves an immense sum in value, there is no difficulty in introducing any amount of expert testimony on either side.' Another judge, in a lecture upon medical expertism, gives a similar opinion, that the ground of dissatisfaction in regard to medical testimony to both the professions of law and medicine, are reducible to one—that upon every conceivable issue expert opinions are procurable which sustain, or seem to sustain, the most contradictory views." But Prof. Himes does not take a pessimistic view of the scientific expert. He is inclined to believe that:—

"The scientific expert is simply a product, and an extreme product, of an advanced and rapidly advancing civilisation. He was recognised in the germ, to be sure, by the old Roman law, and we may assume in all systems of jurisprudence; but he has acquired an immensely increased importance, and a much wider field and a far greater frequency of employment by the recent, and very recent, marvellous advances in the applications of science—applications which have increased the sphere of things to be litigated about, which have introduced facts of an entirely new character to be adjudicated upon, to say nothing of the contribution that science has made, and is continually making, in many ordinary cases, of conclusive missing links of evidence which render decision previously uncertain, comfortably certain, and satisfactory.

"Now, one fact that seems latent in these expressions of the legal profession in regard to the scientific expert and almost the first that impresses is that in many respects he seems to be a positive annoyance to lawyers, and even to judges at times—a sort of intractable, incompatible, inharmonious factor, disturbing the otherwise smooth current of legal procedure; too important or necessary to be ruled out, too intelligent and disciplined mentally to yield without reason to ordinary rules

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